EXHIBIT Z

DEVELOPMENT OF A CLEANING STATION FOR ELECTRIC SHAVERS

Master's thesis submitted by Stefan Zeischke to the Special Field for Precision Engineering and Engineering Computer Sciences of the Technical University of Frankfurt am Main.

Published in cooperation with

Braun AG, Kronberg.

Explanation:

I hereby warrant that the Master's Thesis handed in to the Examiner, Prof. Dr. Völker with the topic:

Development
of a
Cleaning Station for Electric Shavers

was written by me independently and without any outside assistance by individuals or institutes.
To the extent I referred to sources in preparing my Master's Thesis, such sources are completely indicated on the List of References on Page A-15.

Kronberg, on 06/14/1991 [signature]

Prefix

The Master's Thesis below came about in cooperation with

Braun AG in Kronberg.

I would like to thank the employees of Braun AG, who were so kind as to support me in acquiring information and documents.

Dr. Jung, Engineer, deserves special thanks for the support he offered me at Braun, and Prof. Völker for his careful accompaniment of my work at the Technical University of Frankfurt am Main.

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1.0 Summary

An elementary model of a cleaning station was developed, whereby the shaving parts of the Braun Flex Control 6013 are cleaned within 15 s to an average cleaning level of 93%. The shaving head with the blade block and shear blade are introduced one after the other into a cylindrical housing in which a linear brush with two rows is rotated at 3,200 min^{-1}.
The rotational direction of the brush reverses every 5 s, in order to clean the second side of the blade block.
The shaver dust removed with the brush is suctioned through an opening along the perimeter of the housing with a blower and collected in a dust chamber, which is located in front of the fan impeller rotating at 10,000 min^{-1} and the dust filter.
These results were produced by systematically contrasting and assessing solution variants within the current development level.
This preparation forms the basis for further work.

[photo]

Fig. 1.0 Elementary Model of a Cleaning Station

1.1 Problem Formulation

A reasonably-priced cleaning station must be developed for the currently available Braun Flex Control 6013 Electric Shaver, with which the shaving parts can be quickly and easily cleaned after daily shaving.
Users of electric shavers clean their shavers after each shave, but only 29% use the associated, small cleaning brush. 56% clean them by blowing, tapping or shaking their shavers, which leads to the formation of a layer on the blades (cf. Pages A2 – A4).
The shaver should be cleaned after every shave (see Page A–1), since skin, sebum and beard hair are deposited on the blades. If this layer is not regularly removed, then the cutting performance of the shaver declines, depending on the thickness and hardness of the layer.
After a daily shave, the skin sebum can still be easily removed from the blades with a brush, since it has not hardened. If the blade is not cleaned of any skin sebum, then the skin sebum will harden, due to heat produced by friction arising between the blade block and sheer blade. The skin sebum can then still only be removed with great effort.
The cleaning station is intended to make shaver cleaning comfortable. In addition, hygiene is increased and cleaning time significantly shortened, since it is no longer necessary to rid the sink of shaver dust.

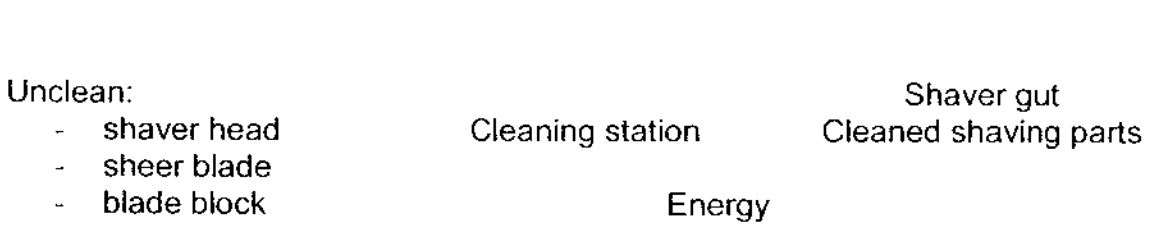

Fig. 1.1 Depiction of a Black Box

1.2 State of the Art

The topic of cleaning electric shavers dates as far back as the electric shaver itself. The development of cleaning aids refers, on the one hand to the shaver, or rather, a shaver with integrated or external suction, a washable shaver, a shaver with devices to scrape off the dust from the blades, etc., and, on the other, to such external instruments as so-called "shaver cleaning instruments, devices or stations."

A few protected rights exist on the topic of cleaning stations. The proposed effective principles are of a diverse nature, extending from

- Immovable brushes, over which the turned-on shaver moves across the blade block using oscillation,
- Simple blower with a filter,
- A rotating radial brush with cleaning fluid,
- A shaking device,
- A brush band with suction, up to
- Separate tiny brushes with suction.

Up to the present time, no cleaning stations are on the market.

8	Take small brush out of cabinet and set aside
16	Remove shear blade carrier, tap on sink edge several times and blow off
18	Set shear blade carrier aside
20	Pick up small cleaning brush
26	Clean blade lock with small brush
28	Turn blade block 90°
34	Clean blade head base with small brush
36	Turn blade block 90°
42	Clean 2nd blade block side with small brush
46	Switch on and blow off
48	Set small brush aside
50	Pick up sheer blade carrier and set up
52	Set shaver aside
60	Pick up small brush and put back into cabinet
75	Clean sink
85	Wash hands
95	Dry hands

[vertical text]
Time t(s)

Fig. 1.3 Procedure with Everyday, Manual Shaver Cleaning

1.4 Distribution of Shaver Dust on the Shaver

In order to investigate the distribution of shaver dust on the shaver (Braun Flex Control) an ongoing study was performed on numerous subjects and various shaving devices. The clean shaving device was weighed before and immediately after shaving, so that the amount of shaver dust collected could be determined from the difference in weight. The measurement was made on a precision scale with digital resolution of 1 mg: precision +/- 1 mg (measurement values in Tables A-7 through A-10). The measurement ranges of each individual measurement were short so that any influence of humidity in the air could be disregarded. The assessment of the relative values results in Diagrams 1.7.1 – 1.7.4 on Page 11.

With a customary, manual shaver cleaning as per Fig 1.3 Page 8, one achieves, with a time expenditure of 95 s, a cleaning level in the shaver body of 94% and 80% at the shear blade (cf. 1.7.2 + 1.7.3). To this must still be added the expenses for water, which is used to rinse the shaver dust out of the sink.

1.5 When is a Cleaning Station Worthwhile?

Fig. 1.7.4 on Page 11 shows that as the age of the beard increases, relatively less shaver dust remains in the shaver. As of a beard age of 4 days, the long hair trimmer is used first, and then shaving is completed with the short hair system. Hair cut with the long hair trimmer is found outside the system boundary of the shaver, or rather, on one's shirt, sink, storage location, etc.
With older beards, the advantages of the station are more pronounced, since the beard hair trimmed using the long hair system cannot end up inside the system boundary of the "Cleaning Station."

1.6 Cleaning Areas on the Shaver

1.6.1 Shaver without Sheer Blade

[see original for figure]

1.
long hair trimmer
blade block

1.6.2 Shear blade

[see original for figure]

2.
Shear foil
Frame

3.
From above:

4.
Corners for dirt

5.
Inside:

[see original for figures]

1.
1.7.1 Cleaning level
Complete shaver

2.
loose dust
simple cleaning
small brush
thorough brushing
Waste

3.
1.7.2 cleaning level
Shaver or shear blade

4.
Cleaning level (%)

5.
Loose dust
switch on shaver
small brush
thorough brushing
Waste

6.
1.7.3 Cleaning level
shear blade

7.
Loose dust
tap off shear blade
small brush
thorough brushing
Waste

8.
1.7.4 dust in the shaver / total dust
(dust outside system boundary)

9.
Dust in the shaver (%)

10.
Beard age (days)

1.8 List of Requirements

Geometry:

Requirements
- construction size similar to mouthwash (Bx Hx T 100x 100x 80)
- Accommodation capacity of shaver dust for 100 shaves
- Exemplary solution for Flex Control 6013
- Develop storage concept
- Simple change of changeable parts
- Pay attention to easy cleaning of the cleaning station

Desire
- Integration: - Wall holder
  - Charging device
- Compatible for other BAG shavers

Energy:

Goal – 220 energy supply; 50 Hz, or battery

Active material:

Requirements:
- Uses no liquid for cleaning
- Uses recyclable plastics

Safety:

Requirements OBSERVE BRAUN working standards (detailed preparation of Safety (VDE) and Quality requirements referring to small devices and/or electric shavers)

Use:

Requirements:
- noise ≤ shaver = 60 dBA noise level
- service life is 60 h (proportional time of use of shavers is at least 200 h)
- removes at least 90% of shaver dust present
- cleaning time ≤ 15 s (time to pick up device)
- only a max. of 10% of the shaver dust removed from the shaver may fall outside
- long hair trimmer and lower housing part should be cleaned as per the established task
- clean shear parts separately from one another

Area of application:

Requirement
- private household, in the bathroom

Costs:

Requirement
- selling price ≤ DM 50.00 (more or less equals 15 – 20% of the peak shaver price) relative to piece counts of 100,000 / year.

General:

Requirement
- environmentally-friendly device concept

[see original for figures]

1. Unclean shaver
2. Remove shaver parts
3. Insert shaver body
   Insert shear blade
   Loose dust falls out
4. Prepare station
   Collect loose dust
5. Energy
6. Activate station
   Remove shaver dust
   Transport shaver dust
   Collect shaver dust
   Deactivate station
7. System boundary
8. Remove shaver dust
9. [illegible] station
10. Remove shaver body
    Remove shear blade
11. Introduce shaver parts
12. Shaver cleaned

2.2 Determination of the Accommodation Capacity for Shaver Dust

V= i*m /8= 100*45 mg/(1.34g/cm^3)+ 3.36 cm^3, with:

V	= Volume
i	= number of shaves
m	= ▲ – mass /day
δ	= hair thickness

2.3.1 Solution Variants in the Individual Functions

Assessment of the Individual Functions

Activation of the cleaning station		
Mechanical	- translatory	- switch
	- rotating	- rotary switch
- Optical	- photoelectric beam	
	- IR sensor	

A distinction must basically be made as to whether the activation should be automatic, by supplying the shaver, or manual. This however depends on the overall concept.

Note on 2.3.2 thorough 2.3.4:

The solution variants of the three following individual's functions of removal, transportation and collection of shaver dust are assessed with + = good, o = average and – = poor. The focus of the assessments lies on the effectiveness of the current, individual function. Its precision is adequate here, since only basic trials or considerations are carried out.

2.3.3 Solution Variants of the Individual Functions
Assessment of the Individual Functions

Function	Solution variants		Assessment
Remove shaver dust			Cleaning effectiveness Constr. Expense Mfg. expense
Mechanical	Rotating Oscillating Scraping Wiping Vibrating Tapping Circulating	brushes, roll toothbrush drive brushes Rubber disk roller Rubber disk roller Shaver Shaking mechanism Tap out shaver Belt with brushes	[see original]
Pneumatic	Suction Blowing Pressure waves Sand beams	Subcompression pump Fast rotating brushes Pump Blow particles onto shear head and separate electrically	[see original]
Electrical	Ultrasound Pressure waves Polarization Microwaves	Piezo (Resonance) Loud speaker Condenser principle Magnetron	[see original]
Optical	Infrared Laser beam		[see original]
Chemical	Oxidation/ Reduction Cohesion/ Adhesion	Gas Plasticine Wax	[see original]

+ = good
o = average
- = poor
The assessment priority lies with the cleaning effect, which indicates that only brushes are able to clean well. All other solution variants are excluded.

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2.3.3 Solution Variants of the Individual Functions

Assessment of the Individual Functions

Function	Solution Variant	Assessment
Transporting shaver dust		Cleaning effectiveness Construction Expense Mfg. expense
Mechanical	Conveyor belt Acceleration Centrifugal force (fast rotating brushes → flow channel) Soft brushes with a wiper	[see original]
Pneumatic	Suction (vacuum pump) Blowing (blower) Suction and blowing (use exhaust from suction from blowing)	[see original]
Electrical	Statically charged surface	[see original]

+ = Good
o = Average
- = Poor

A conveyor belt is too expensive and requires a lot of construction room. It must therefore be excluded.

LV1t*: It must be determined experimentally whether mechanical transportation by centrifugal force or soft brushes with a wiper are effective enough, since construction and manufacturing mean less expense, or:

LV2t*: Whether a pneumatic solution is required, which would necessitate additional expense.

* LV1t= Solution variant 1 transporting shaver dust
* LV2t= Solution variant 2 transporting shaver dust

2.3.4 Solution Variants of the Individual Functions

Assessment of the Individual Functions

Function	Solution Variant		Assessment
Remove shaver dust			Collection effectiveness Constr. Expense Mfg. Expense
Mechanical	Mass inertia	Box Filter Dust bag	[see original]
Electrical	Statically charged surface		[see original]
Chemical	Cohesion/ Adhesion	Plasticine Wax	

+ = Good
o = Average
- = Poor

It must be taken into account, when collecting the shaver dust, that the smallest dust particles have a particle size of 20 µm. The decision as to which solution variant is more appropriate depends on the selection of the transportation solution variant. Only a box, filter or dust bag seem attainable.

2.3.5 Solution Variants of the Individual Functions

Assessment of the Individual Functions

Deactivate cleaning station		
Mechanical	Translatory	Switch
	Rotating	Rotary switch
Optical	Photoelectric beam	
	IR sensor	

Here, as well, a distinction must be made as to whether deactivation should occur automatically by removing the shaver, or manually; this depends on the overall concept.

In case of an optical embodiment, deactivation is possible by means of dust control: If only a certain number of shaver dust particles per unit volume (ppm) is still available, then the cleaning station automatically switches off.

einfach = simple
kombiniert = combined

konzept = concept
technisch zu aufwendig = technically too expensive
translatorisch = translatory
tech. nicht möglich = technically impossible
rotarisch nicht sinnvoll = rotationally not worthwhile
nicht sinnvoll = not worthwhile
techn. aufwendig = technically costly

[remainder of text cut off]

Note on 2.5.1 through 2.5.10:

The following 10 brush concepts are roughly sketched out and described with meaningful concept-specific notes. A valuation of all concepts may be found on Page 31.

2.5.1 Brush Concept 1

Three small radial brushes; rotating blade block

[see original]

SHAVER SHAVER

Disadvantages:
- Cutting block turning: additional manual expenditure
- Problems with sealing the housing opening, due to a rotating blade block
- Problems with the rotational directional brushes
- Many individual parts
- Operating noise due to the toothed wheels

Advantages:
- Good cleaning level

2.5.2 Brush concept 2

Brushes moving up and down

[see original]

SHAVER SHAVER

Disadvantages:
- Strong mechanical demand on the brushes
- No cleaning - of the underside of the blades
  - of the undercut
  - of the shear chamber bottom
- Change in rotation of the motors in translation of the brushes

2.5.3 Brush Concept 3

Electrical toothbrushes as brush drive

[see original]

Brush movement:

1.)

Braun dc2
Powerdent

2.)
Braun dc1
Powerdent

3.)
Modified
Powerdent
Interplak

SHAVER

Disadvantages:
- Combined drive (1) not convincing in the test
- with transverse movement (2), generally poor cleaning
- with longitudinal movement (3):
  - 4 mm stroke: with electric Powerdent toothbrush: moderate cleaning
  - 12 mm stroke: with modified, electric Interplak toothbrush: improved cleaning
  - longer stroke – better cleaning
- in general, no cleaning
  - of the blade underside
  - of the shear chamber bottom
  - of the undercut

2.5.4 Brush Concept 4

Electrical toothbrush as brush drive

[see original]

SHAVER

In the test:

Braun dcl
Powerdent

Swinging

Disadvantages:
- No cleaning:
  - of the blade underside
  - of the shear chamber bottom
  - of the undercut

2.5.5 Brush Concept 5

Inter-plaque system: 10 individual, rotating brushes are driven by an oscillating rack and pinion. The displacement of the rack and pinion is so great that the brushes reverse their rotational direction every 1.5 revolutions. This prevents buckling.
This principle is patented.
The individual brushes have a diameter of 2 mm, and consist of individual bristles of a diameter of 0.15 mm. The brush distance amounts to 4 mm and the length to 10 mm.

[see original]

[1]
SHAVER
[2]
BRISTLES
RACK AND PINION
TOOTHED WHEELS

Disadvantages:
With original bristles no cleaning:
- of the blade underside
- of the shear chamber bottom
- of the undercut
- with non-oscillating rotation, the 10 mm long original blades buckle out
- 25 mm long, individual brushes (cleaning depth of the shaver body) buckle out and have difficulties in rotation between the blades: no cleaning:
  - of the blade underside
  - of the shaver base
- many individual parts such as:
  - brushes
  - toothed wheels
  - rack and pinion
- Conversion of rotation of the motor in oscillating translation of the rack and pinion; subsequently in oscillating rotation of the brushes

Advantages:
- Very good cleaning between the blades
- Bristles do not become entangled in shear foil
- Individual brushes clean dirty corners in the shear blade

2.5.6 Brush Concept 6

Brush band with wiper

[see original]

COLLECTION SHAVER WIPER

Disadvantages:
- No cleaning: - of the blade underside
  - of the shear chamber bottoms
  - only one blade side, depending on rotational direction
- Expensive manufacture of the brush band

Advantages:
- Possibly no suction necessary

2.5.7 Brush Concept 7

Two rotating contour brushes:
- long bristles for shaver base
- short bristles for blades

[see original]

SHAVER SHAVER

Disadvantages:
- contour brushes are more expensive than straight brushes
- long bristles do not buckle under the blade to clean the shaver base
- no cleaning of the blade underside
- many individual parts, such as: - brushes
  - toothed wheels
- With a high rotational speed, considerable running noise caused by toothed wheels can be expected
- Construction size too large with the use of long bristles only

Advantages:
- good cleaning between the blades
- no reversal of rotational direction of the motor necessary → advantage with the eventual integration of a suction device, see Page 38 "Criticism and Prospects" under "Fan Impeller."
- usable with one hand
- with the use of long bristles only very good cleaning in all areas

2.5.8 Brush concept 8

Rotating brushes with additional translator XXX movement

[see original]

SHAVER SHAVER

Disadvantages:
- For each movement a motor is necessary
- Depending on the rotational direction of the brushes, cleaning on only one blade side

Advantages:
- One side of the shaver is cleaned well with long bristles
- No reversal of rotational direction of the motor necessary → advantage with the possible integration of a suction device, see Page 38 "Criticism and Prospects" under "Fan Impeller."

2.5.9 Brush Concept 9

Rotating brush with additional, manual rotation of the shaver

[see original]

SHAVER SHAVER

Disadvantages:
- Sealing problems
- Severe strain on the bristles, due to the rotation of the shaver

Advantages:
- No reversal in rotational direction of the motor necessary → advantage with the possible integration of a suction device, see Page 38, "Criticism and Prospects" under "Fan Impeller."

2.5.9.1 Brush Concept 10

Brush with reversal of rotational direction

[see original]

SHAVER

for t = x s in each direction

Disadvantages:
- Motor must be able to change rotational direction
- Problems with the possible integration of a suction device, due to the rotational direction of the fan impeller

Advantages:
- May be operated with one hand
- With long bristles very good cleaning in all areas
- Acceptable construction size, even with long bristles
- is selected, see Table on Page 31